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To Sankyo Patent Attorneys Office

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may comprise any polyol other than the polycarbonate polyol, as long as the amount thereof to be used is less than 45% by mass based on the total amount of the used polyol. In a preferable embodiment, all of the polyol component is the polycarbonate polyol.

Examples of usable polyols other than the polycarbonate polyol include low-molecular-weight diols such as ethylene glycol, diethylene glycol, triethylene glycol, 1,3-butanediol, 1,4-butanediol, neopentyl glycol, and 1,6-hexanediol; low-molecular-weight triols such as glycerin, trimethylolpropane, and hexanetriol; and polymer polyols such as polyether polyol, polyester polyol, lactone type polyester polyol, and acrylic polyol.

Examples of the polyisocyanate compound for use as a raw material of the isocyanate group-terminated urethane prepolymer include, without any particular limitation, aromatic diisocyanates such as 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate and a mixture (TDI) of 2,4-tolylene diisocyanate and 2,6-tolylene diisocyanate, 4,4'-diphenylmethane diisocyanate (MDI), 1,5-naphthylene diisocyanate (NDI), 3,3'-bitolylene-4,4'-diisocyanate (TODI), xylylene diisocyanate (XDI) and paraphenylene

diisocyanate (PPDI); and alicyclic or aliphatic diisocyanates such as 4,4'-dicyclohexylmethane diisocyanate (hydrogenated MDI), hexamethylene diisocyanate (HDI) and isophorone diisocyanate (IPDI), or mixtures of at least two of them. Among them, TDI or MDI is preferably used because the resulting polyurethane cover has favorable mechanical properties and a golf ball with the resulting polyurethane cover is satisfactory in repulsion property, weather resistance and water resistance.

The isocyanate-terminated urethane prepolymer is obtained by mixing the polyisocyanate compound and a polyol comprising the above polycarbonate polyol so that the molar ratio of OH group:NCO group ranges from 1.5:1 to 8 : 1 and allowing them to react with each other.

The free NCO content of the isocyanate-terminated urethane prepolymer used in the present invention is from 3 to 20% by mass, preferably from 5 to 15% by mass. Since free NCO

manufactured was 100.

6. Shot feeling

The shot feeling of each golf ball shortly after manufactured was evaluated in the following manner. Ten top-level amateur golfers actually hit each golf ball with a metal head driver W#1. Each golfer judged each golf ball to be good or bad synthetically in view of the impact strength upon a shot and a sensation of repulsion imparted thereby. Each golf ball was rated in such a level that "○" is the case that less than two golfers judged the golf ball to be bad, "△" is the case that two to five golfers judged the golf ball to be bad, and "×" is the case that at least six golfers judged the golf ball to be bad.

[Influence of the polyol component constituting a urethane prepolymer]

(1) Manufacture of Solid Core

The rubber composition of the formulation shown in Table 1 was vulcanized and molded at 160°C for 30 minutes, to form a spherical solid core having a diameter of 40.0 mm.

In Table 1, butadiene rubber is "high-cis polybutadiene BR-01 (cis content: 96%)" produced by JSR Corp.; zinc acrylate is "ZNDA 90S" produced by

NIPPON JYORYU CO.; zinc oxide is "Toho Zinc oxide No.1"; and dicumyl peroxide is one produced by NOF Corp.

Table 1

(2) Synthesis of Prepolymer

4,4'-diphenylmethane diisocyanate (produced by Nippon Polyurethane Industry Co.) was mixed with a polycarbonate diol represented by the following formula (produced by UBE Industries), polytetramethylene ether glycol (produced by BASF JAPAN Co.) or poly(ethylene adipate) glycol (produced by Sanyo Chemical Ind.) having respective number-average molecular weight shown in Table 2 in a blending molar ratio between the NCO group and the OH group (NCO/OH) of 4/1. The resulting mixture was reacted at 70°C for 3 hours in a nitrogen atmosphere while being stirred. Thus, isocyanate-terminated urethane prepolymers having respective NCO contents (% by mass) and respective number-average molecular weights shown in Table 2 were each synthesized.

[Formula 2]

(3) Manufacture of Cover

The isocyanate-terminated urethane prepolymer thus synthesized was mixed with 1,4-butanediol (produced by BASF JAPAN Co.) in an amount such that

the molar ratio(OH/NCO) of the hydroxyl group of the
curing agent to the isocyanate group of the urethane
prepolymer is ~~1.05~~ 0.95.

Further, titanium oxide was added in an amount of 2 parts by mass to 100 parts by mass of the total of the urethane prepolymer and the curing agent, to prepare a viscous liquid of a cover composition.

The cover composition thus prepared was injected into a hemispherical mold formed with convex portions for forming dimples in which the previously manufactured core was held, and then this mold was inverted and mated with another hemispherical mold (also formed with convex portions for forming dimples) containing the cover composition injected thereinto, followed by press molding at 80°C for 15 minutes to cure.

After the curing, the resulting golf ball was removed from the molds, deburred, and then coated with a white paint and further with a clear paint on the surface thereof to obtain golf balls Nos. 1 to 7 each having a diameter of 24.8 mm and a mass of 45.2 to 45.7 g.

Golf ball No. 8 was manufactured in the same manner as with golf ball No. 2 except that Elasmer 250P was used as the curing agent. Elasmer 250P is polytetramethyleneoxide aminobenzoate (amine value: 249.4 mgKOH/g) produced by Ihara Chemical Ind.

According to the evaluation methods described above, each golf ball shortly after manufactured was evaluated as to its hardness, repulsion property and shot feeling. Further, the heat resistance test, weather resistance test and water resistance test were conducted on each golf ball according to the evaluation methods described above. The results along with the composition of each urethane prepolymer are shown in Table 2.

Table 2

Golf ball No. 6 manufactured by using polytetramethylene ether glycol (PTMG) as the polyol component exhibited an initial repulsion index of 100, which was equal to the initial repulsion index of golf ball No. 1 as an working example of the present invention. However, the repulsion index of golf ball No. 6 after any one of the heat resistance test, weather resistance test and water resistance test was inferior to that of golf ball No. 1. Thus, golf ball No. 6 was inferior in repulsion durability. Golf ball No. 7 manufactured by using poly(ethylene adipate) as the polyol component exhibited a particularly lowered repulsion index after the water resistance test.

From comparison among golf balls Nos. 1 to 5

each manufactured by using a polycarbonate diol as the polyol component, it was found that the initial repulsion property was lowered when the molecular weight was either too small (golf ball No. 4) or too large (golf ball No. 5). Golf ball No. 4, in particular, exhibited a lowered repulsion property in spite of its increased ~~height~~ **hardness** . Since the polyol component forming a urethane prepolymer is considered to serve as a soft segment, it is conceived that the polyol component is required to have a large molecular weight to a certain extent so as to impart a golf ball with a satisfactory repulsion property.

[Influence of the free NCO content of a urethane prepolymer]

(1) Manufacture of Solid Core

The rubber composition of the formulation shown in Table 1 was vulcanized and molded at 160°C for 30 minutes, to form a spherical solid core having a diameter of 40.0 mm.

(2) Preparation of Urethane Prepolymer

4,4'-diphenylmethane diisocyanate (produced by Nippon Polyurethane Industry Co.) was mixed with a polycarbonate diol (produced by UBE Industries) having a number-average molecular weight of 1987 at a mixing molar ratio (MDI:PCG) varied as shown in Table 3, to prepare isocyanate-terminated urethane prepolymers Nos. 11 to 15 having respective NCO contents (% by mass) and respective number-average molecular weights shown in Table 3.

(3) Manufacture of Cover

Each of the isocyanate-terminated urethane prepolymers thus synthesized was mixed with 1,4-butanediol (produced by BASF JAPAN Co.) in an amount such that the molar ratio of the hydroxyl group of the curing agent to the isocyanate group of the urethane prepolymer (OH/NCO) is ~~1.05~~ 0.95. Further, titanium oxide was added in an amount of

2 parts by mass to 100 parts by mass of the total of the urethane prepolymer and the curing agent to prepare a viscous liquid of cover compositions.

In the same manner as golf ball No. 1, golf balls Nos. 11 to 15 were manufactured using each of the cover compositions thus prepared and the core manufactured as described above.

According to the evaluation methods described above, each golf ball shortly after manufactured was evaluated as to its hardness, repulsion property and shot feeling. Further, the heat resistance test, weather resistance test and water resistance test were conducted on each golf ball according to the evaluation methods described above. The results along with the composition of each urethane prepolymer are shown in Table 3.

Table 3

The urethane prepolymer having a low free isocyanate content gave an inferior initial repulsion property and a poor shot feeling to the golfers(No.12), because it is presumably considered that the obtained polyurethane cover has a lowered crosslinking density and becomes soft. On the other hand, the initial repulsion property became higher as the free isocyanate content of a urethane

prepolymer increased. However, when the free isocyanate content was more than 15% by mass, the shot feeling was too bad for practical use (No.15).

[Effect of the invention]